Forage Res., **51**(3) : pp. 389-394 (2025) **http://forageresearch.in**

EFFICACY OF BOTANICAL EXTRACTS AGAINST LEAF BLIGHT PATHOGEN *DRESCHLERA AVENAE* INFECTING FODDER OAT

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(Received: 12 December 2025; Accepted: 26 December 2025)

SUMMARY

Leaf blight, caused by *Drechslera avenae*, is one of the most important foliar diseases of oat in North western India. Study aimed to assess the extracts of various botanicals under *in vitro* and *in vivo* conditions against leaf blight pathogen affecting oat crop. The study was conducted for two years during the winter of 2021-22 and 2022-23. A total of eleven leaf extracts were evaluated under in vitro conditions, and among them *Cymbopogon citratus* and *Aegle marmelos* were found most effective botanicals against *Drechslera avenae*, exhibiting more than 92% mycelial growth inhibition at 10% concentration followed by *Murraya koenigii* (91%) and *Melia azedarach* (88%). Under field conditions, seven botanical extracts were tested and the minimum disease severity (12.90%) was recorded in the treatment *A. marmelos as compared to control (43.84%) followed by M. azedarach* (18.78%) with 70.57% reduction in disease, and resulted in the maximum green fodder yield of 567.5 q ha^{-1}, representing 41.62 per cent increase in yield over the control (400.7 q ha^{-1}). Thus, these botanicals can be used as one of the management strategies against leaf blight.

Key words: Oat, *Dreschlera avenae*, plant extracts and antifungal activity

Oat (*Avena sativa*) is one of the major cereal crops grown in temperate and subtropical regions for use as fodder, grain, hay, silage, bedding straw and chaff in different regions of the country. Its forage is highly palatable, nutritious, and digestible, making it an ideal feedstuff for ruminants (Satpal *et al*., 2024). The major oat growing areas in India are Punjab, Haryana, West Bengal, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan and Maharashtra. In Punjab, it occupies 1.06 lakh ha area (Anonymous, 2022-23) and highly admired by farm animals. It has highly nutritious value that is notably high in fat, protein, vitamin B_1, phosphorus and iron (Pradhan and Mishra, 1994). It provides high nutritious green fodder as compared to other crops that remain dormant during winter months. Feeding of livestock with green oat fodder is an excellent and affordable means of maintaining livestock in good condition since it enables reduction in the concentrated ration.

In all oat growing areas, fungal diseases like crown rust, stem rust, leaf blotch and leaf spot infect oat crop. Among fungal diseases, leaf spot incited by *Drechslera avenae* is particularly devastating one. The disease has been reported to appear in all growth stages from seedling to maturity of crop (Soovali, 2010). Yield losses up to 30-40% have been reported due to epidemic of leaf spot in Germany and southern US (Gough and McDaniel 1974). Initial symptoms first appear as oblong to elongate, necrotic dark brown lesions (1-3 × 1-2 mm) on the seedlings after emergence which causes mortality of plants whereas symptoms on young leaves appear as reddish to dark black coloured spots on upper surface of leaves. The lesions are primarily constrained by veins, however they grow and enlarge to produce elongated, massive dark brown to grey patches. Tissues disintegrated, dry up as the disease progresses and the leaves becomes wilted. This disease has potential to significantly reduce both quality and quantity of green fodder.

Various integrated management strategies have been used to limit the yield losses caused by leaf blight disease (Paveley *et al.*, 1996), such as crop rotation, tillage and removal of crop debris (Harder and Haber, 1992), seed treatment and foliar sprays with fungicides Margot *et al.*, 1998), use of biological control agents and deployment of resistant varieties (Sebesta *et al.*, 1995). However, use of plant extracts as non chemical means is useful method for its management. Botanicals as natural products with antifungal properties against wide range of pathogens are widely used to control

plant diseases. Several workers have reported the effectiveness of numerous botanicals against leaf blight fungi in crops like barley, oat and wheat. Plant extracts of *Melia azedarach*, *Murraya koenigii* and *Azadirachta indica* were found more effective against leaf blight of oats and also increased green fodder and grain yield (Atri and Tiwana, 2019). The biologically active components found in them may either have direct or indirect antimicrobial actions and they stimulate the host defense mechanism in plants which restricts the further spread of disease (Schneider and Ullrich, 1994). Hence, they can be used to manage plant diseases in a sustainable manner. Extracts of various plants also found effective against innumerable plant pathogens in various crops but not much work has been done in oats. Keeping these points in view, the present research work was undertaken with the objectives to evaluate the effects of plant extracts on leaf blight severity and green fodder yield.

MATERIALS AND METHODS

Preparation of plant extracts

Leaves of eleven plants namely *Nicotiana tabacum, Ricinus communis, Azadirachta indica, Melia azedarach, Murraya koenigii, Datura stramonium, Curcuma longa, Calotropis gigantean, Aegle marmelos, Cymbopogan citrates* and *Ocimum tenuiflorum* were collected from the surroundings of Punjab Agricultural University, Ludhiana, Punjab. Selection of plants was based mainly on reports that they have antifungal properties against plant pathogens (Pandey, 2015; Sales et al., 2016; Chen *et al.*, 2018). The plant leaves were washed in running tap water, rinsed with sterilized distilled water thrice and then air dried for 4-5 hours. The fine dry powder was prepared by grinding plant material in a blender and fifty gram fine powder was soaked overnight in 100 ml sterilized distilled water (1:2 w/v), filtered through double layer of muslin cloth and stored in conical flasks in refrigerator for further use (Devi and Chhetry, 2013).

In vitro response of plant extracts against *D. avenae*

The response of plant extracts against *D. avenae in vitro* was studied by following the poisoned food technique of Grover and Moore (1962) at 2.0, 4.0, 6.0, 8.0 and 10.0% concentrations. Requisite quantity of double strength sterilized PDA medium was amended with varying quantity of plant extracts and aseptically poured in sterilized plates to give final concentrations of 2%, 4%, 6%, 8% and 10%. Medium mixed with equal quantities of distilled sterilized water without any treatment served as control. Seven days old mycelial bits (5 mm) were placed in the centre of plates and plates were incubated at 25+1°C. The treatments were replicated thrice and Completely Randomized Design (CRD) was adopted with twice repetition of experiment. Inhibition in mycelial growth over control (I) was calculated using the following formula given by Vincent (1947).

$$I(\%) = \frac{\text{Mycelial growth in control - Mycelial growth in treatment}}{\text{Mycelial growth in control}} \times 100$$

Evaluation of plant extracts against leaf blight pathogen under field conditions

The plant extracts that exhibited strong antifungal efficacy against leaf blight pathogen *in vitro* were further tested against *D. avenae* during two consecutive *Rabi* seasons in 2021-22 and 2022-23 at PAU, Ludhiana. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications per treatment. Variety OL 15 was sown by following recommended agronomic practices as per Punjab Agricultural University Package of practices for crops, *Rabi* 2021-22. The seeds of oat were sown in individual plots with 3 x 3 m^2 size. The most effective plant extracts were selected and applied as two foliar sprays at the rate of 10%. First spray was applied at 25 days after sowing and second 20 days after first spray.

Assessment of disease severity and green fodder yield

Leaf blight severity (%) was measured on ten randomly selected plants per treatment per replication at seven-day intervals until maturity using the 0-9 disease rating scale of James (1971). The percent disease index was calculated by using the following formula (Wheeler, 1969):

$$PDI = \frac{\text{Sum of all numerical rating}}{\text{Total nuber of plants graded} \times \text{Maximum grade}} \times 100$$

Disease intensity was measured with area under disease progress curve (AUDPC) was calculated

by using Prescott *et al*. (1986) formula. The green fodder yield was recorded at 75days after sowing, and the green fodder yield was recorded. To record the green fodder yield in the different treatments, crops were harvested manually by cutting the crop from the entire plot, followed by weighing (kg per plot), and the data are expressed as quintals per hectare (q/ha) from each treatment.

Statistical analysis

All experimental data were analysed using ANOVA (SAS software version 9.3) and Fisher's Least Significance Difference (LSD) test with 95% confidence level was used for computing treatment statistically significant means.

RESULTS AND DISCUSSION

***In vitro* efficacy of plant extracts against leaf blight pathogen**

Leaf extracts of eleven botanicals were evaluated *in vitro* conditions and the experimental results revealed that *Cymbopogon citratus* and *Aegle marmelos* were the most effective botanicals against *Drechslera avenae*, exhibiting almost identical levels of mycelial growth inhibition (Table 1 and Fig. 1). Both exhibited significantly higher mycelial inhibition, recording 92.96 per cent at 10 per cent concentration. This was followed by *Azadirachta indica* and *Murraya koenigii* with 91.67 and 88.89 per cent mycelial inhibition respectively. The least inhibitory effect was recorded with *Datura stramonium* (67.59%) at highest 10 per cent concentration.

The present results were consistent with the findings of Narayan (2004) who reported that mycelial growth inhibition of *H. sativum* upto 62.42% was provided by neem leaf extract at 10% concentration. Kaur *et al.* (2020) evaluated the effect of botanicals to manage *Bipolaris sorokiniana* causing spot blotch in barley under *in-vitro* conditions and found that neem (*Azadirachta indica*) extract at 15% concentration reduced the growth of *B. sorokiniana* by 65.48%. Similarly, aqueous fruit extract of *Azadirachta indica* induces systemic acquired resistance in barley against *Drechslera graminea* was demonstrated by Bhuvaneswari *et al.* (2012).

Efficacy of plant extracts under field conditions

Based on *in vitro* studies, seven botanical extracts were selected for evaluation under field conditions (Table 2). The results presented in Table 2 and Fig. 2 indicated that, under field conditions at 10 per cent (w/v) concentration, the minimum disease

TABLE 1
Efficacy of plant extracts against leaf blight pathogen *in vitro*

Name of Plants	Concentration of plant extracts (% w/v)									
	2.0		4.0		6.0		8.0		10.0	
	A	B*	A	B	A	B	A	B	A	B
Nicotiana tabacum	39.17^{b}	56.48	37.67^{b}	58.15	34.33^{b}	61.85	32.50^{ab}	63.89	23.83^{b}	73.52
Ricinus communis	53.50^{a}	40.56	43.50^{a}	51.67	36.67^{a}	59.26	34.33^{a}	61.85	24.83^{b}	72.41
Azadirachta indica	15.00^{e}	83.33	11.67^{fg}	87.04	10.67^{f}	88.15	9.83^{fg}	89.07	7.50^{e}	91.67
Melia azedarach	21.00^{d}	76.67	17.83^{e}	80.19	14.67^{e}	83.70	13.17^{e}	85.37	10.00^{d}	88.89
Murraya koenigii	13.33^{e}	85.19	11.17^{fg}	87.59	9.83^{fg}	89.07	8.33^{gh}	90.74	7.67^{e}	91.48
Datura stramonium	39.33^{b}	56.30	37.00^{b}	58.89	34.17^{b}	62.04	32.17^{b}	64.26	29.17^{a}	67.59
Curcuma longa	34.67^{c}	61.48	27.50^{d}	69.44	24.50^{d}	72.78	22.50^{d}	75.00	19.67^{c}	78.15
Calotropis gigantean	41.33^{b}	54.07	34.67^{c}	61.48	29.67^{c}	67.04	26.67^{c}	70.37	23.17^{b}	74.26
Aegle marmelos	14.17^{e}	84.26	9.33^{g}	88.89	8.67^{g}	90.37	7.83^{h}	91.30	6.83^{e}	92.41
Cymbopogan citrates	35.83^{c}	60.19	9.67^{g}	89.26	8.33^{g}	90.74	7.50^{h}	91.67	6.33^{e}	92.96
Ocimum tenuiflorum	19.17^{d}	78.70	12.67^{f}	85.93	11.00^{f}	87.78	10.67^{f}	88.15	9.50^{d}	89.44
CD (*P*=0.05)	2.321	-	1.376	-	1.020	-	1.183	-	1.028	-
SE ± (m)	0.817	-	0.484	-	0.359	-	0.416	-	0.362	-
CV (%)	6.741	-	5.149	-	4.346	-	5.457	-	5.783	-

A - Mycelial growth (mm), B –Percent Mycelial Inhibition.
*Mycelial growth in control plate - 90 mm.

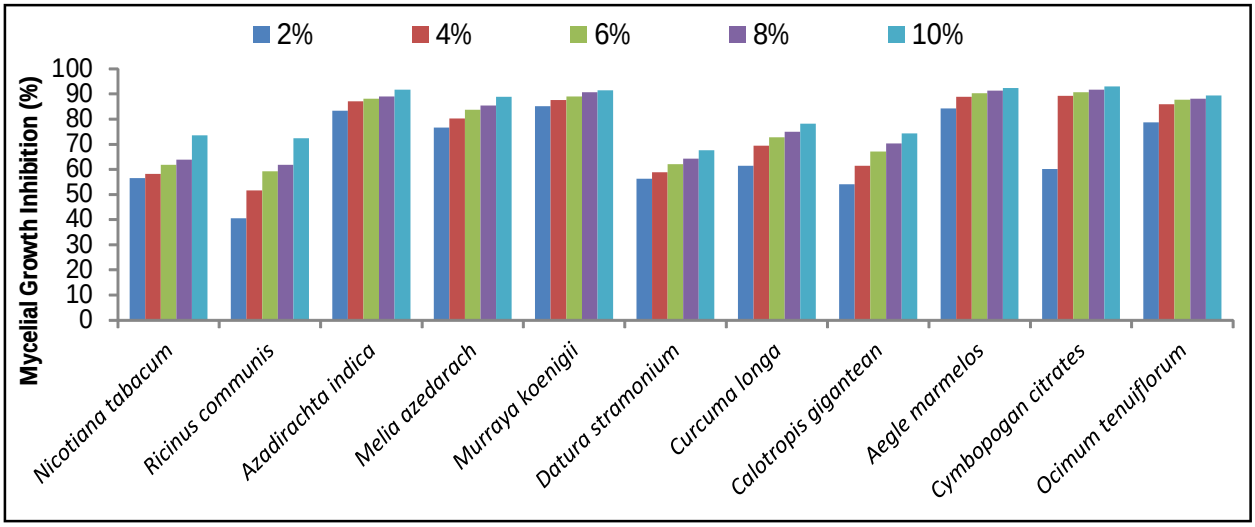

Fig. 1. *In vitro* evaluation of plant extracts against leaf blight pathogen.

TABLE 2
Efficacy of plant extracts against leaf blight pathogen under field conditions

	Treatments	Disease severity (%)	Disease control (%)	AUDPC	GFY (q/ha)	Increase in yield (%)
T1	*Cymbopogan citrates* @ 10%	32.15^{b}	26.67	1198.3^{bc}	416.0^{cd}	3.82
T2	*Ocimum tenuiflorum* @ 10%	30.07^{c}	31.41	1129.3^{c}	442.9^{c}	10.53
T3	*Murraya koenigii* @ 10%	27.00^{d}	38.41	1280.5^{b}	485.7^{b}	21.20
T4	*Curcuma longa* @ 10%	28.09^{d}	35.92	1219.7^{bc}	450.7^{c}	12.47
T5	*Aegle marmelos* @ 10%	12.90^{g}	70.57	569.5^{f}	567.5^{a}	41.62
T6	*Azadirachta indica* @ 10%	23.89^{e}	45.51	949.2^{d}	494.9^{b}	23.51
T7	*Melia azedarach* @ 10%	18.78^{f}	57.16	807.5^{e}	509.0^{b}	27.03
T8	Control	43.84^{a}		1922.5^{a}	400.7^{d}	
	CD (P=0.05)	1.914		92.671	34.948	
	SE ± (m)	0.625		30.259	11.411	
	CV (%)	3.995		4.619	4.197	

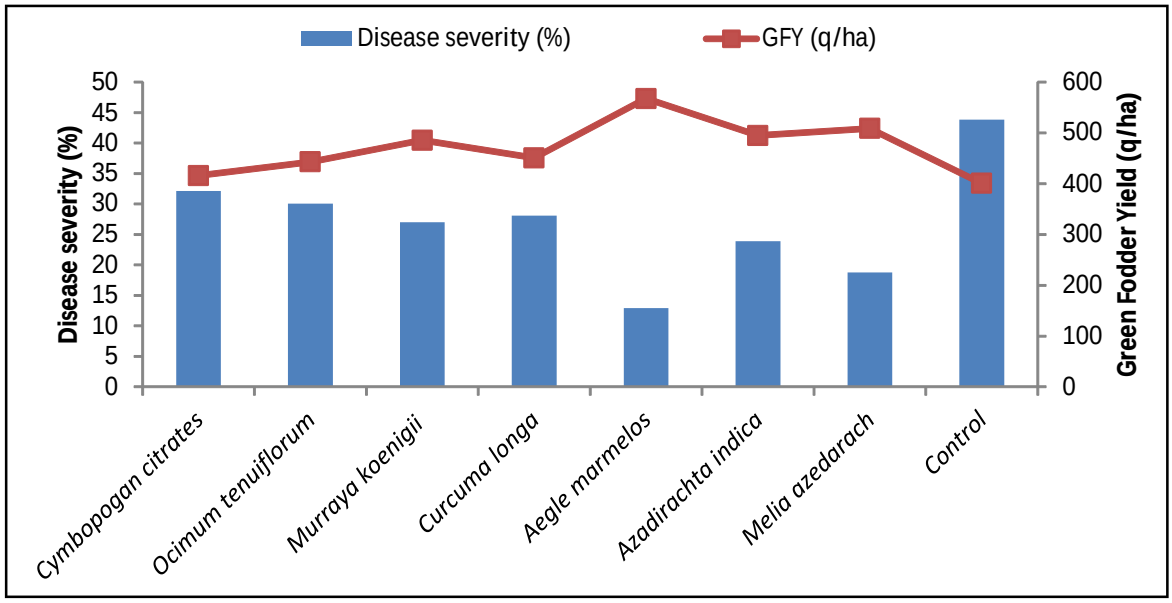

Fig. 2. Evaluation of plant extracts against *Dreschlera avenae* under field conditions.

severity 12.90% was recorded in the treatment *A. marmelos as compared to control (43.84%)*. This treatment also exhibited the highest disease control 70.57%, with an AUDPC value of 569.5, and resulted in the maximum green fodder yield of 567.5 q ha^{-1}, representing 41.62 per cent increase in yield over the control (400.7 q ha^{-1}). This was followed by *Melia azedarach*, which recorded a disease severity of 18.78 per cent, an AUDPC value of 807.5, and 57.16 per cent disease control. The green fodder yield under this treatment was 509.0 q ha^{-1}, corresponding to 27.03 per cent increase in yield. Treatments with *Azadirachta indica* and *Murraya koenigii* resulted in disease severities of 23.89 per cent and 27.00 per cent, with AUDPC values of 949.2 and 1280.5, respectively. These treatments provided disease control of 45.51 per cent (*A. indica*) and 38.41 per cent (*M. koenigii*), and produced green fodder yields of 494.9 and 485.7 q ha^{-1}, corresponding to a 23.51 per cent and 21.20 per cent increase in yield respectively. The minimum efficacy was observed with *Cymbopogon citratus*, which recorded the highest disease severity (32.15%), an AUDPC value of 1198.3, and the lowest disease control (26.67%). This treatment resulted in a green fodder yield of 416.0 q ha^{-1}, with only a 3.82 per cent increase in yield.

Several research workers have tested environment friendly plant disease management techniques in the past by utilizing various plant extracts such as *Eucalyptus*, *Jatropha curcas*, *Azadirachta indica* and *Ocimum tenuiflorum* with antifungal activities against a wide range of plant diseases (Roopa *et al.*, 2014). Kumar *et al.* (2009) reported that plots treated with leaf extracts of *Ocimum tenuiflorum* (14.5 q/ha) and *Azadirachta indica* (15.3 q/ha) against maydis leaf blight of maize resulted in substantially increased grain yield. Plant extracts may have fungicidal characteristics as they contain flavonoid, phenolic and saponin compounds (Rinez *et al.*, 2013). Similarly, it was discovered that 10% concentration of *Rauvolfia serpentine* leaf extract may reduce wheat spot blotches caused by *Bipolaris sorokiniana* (Malik *et al.*, 2008). Paul (2002) demonstrated that barley become resistant to leaf stripe disease when treated with leaf extracts of *Azadirachta indica*. Studies on the eco- friendly management of leaf blight of wheat caused by *Bipolaris sorokiniana* were conducted by Zaman *et al*. (2009) who found that leaves treated with neem extract had noticeably higher activity of enzyme such as Phenylalanine ammonia lyase (PAL) and Tyrosine ammonia lyase (TAL), in addition to quick and clear increase in phenolic chemicals which led to greatest reduction in leaf infection over control.

CONCLUSION

Based on the study, it is evident that the severity of leaf blight was significantly lower with the application of leaf extracts of *Cymbopogon citrates*, *Aegle marmelos, Murraya koenigii* and *Melia azedarach* among eleven tested botanical extracts under *in vitro* conditions. Depending on the results of *in vitro* studies, seven botanical extracts were selected for *in vivo* studies at 10% concentration. Two years' experimentation revealed that least disease severity (12.90%) was exhibited with the application of *A. marmelos as compared to control (43.84%) followed by M. azedarach* (18.78%) with 70.57% reduction in disease and highest green fodder yield.

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